REMARKS

Claims 1-5 and 7-25 are pending. Independent claims 1, 4, 5, 7 and 20 were amended to incorporate the subject matter of claim 6. Claim 6 was cancelled. No new matter was added.

I. The § 112 Rejections Should Be Withdrawn

Independent claim 20 was rejected under § 112, ¶1 as being not enabled for the claimed silicon range, and under § 112, ¶2 as being indefinite for containing the term "relatively small amount." These rejections are respectfully traversed.

Claim 20 recites a relatively small amount of silicon not less than 0.4 wt %. As explained in the previous response, this claimed amount is commensurate in scope with the examples provided in the specification. Thus, this term is limited to a few percent silicon, but below 5 or 10 wt.% silicon suggested in the Office Action. Applicants submit that the specification enables the claimed silicon range because this claimed range is commensurate in scope with the present specification.

Furthermore, applicants submit that the term "relatively small amount" complies with § 112, ¶2 because one of ordinary skill on the art can ascertain the metes and bounds of this range. As discussed in the previous response, persons of ordinary skill in the art can recognize the effective amount of silicon that can be used in a steel to achieve desired results based on reading the present specification and the prior art. For example, the specific examples of the present specification illustrate that 1.23 wt.% silicon is a "relatively small amount." However, the upper range of silicon may also be a fraction of a percent higher depending on the other alloying elements in the steel. However,

one of ordinary skill in the art can easily determine this range without undue experimentation.

II. The § 103(a) Rejections Should Be Withdrawn

Independent claim 20 was rejected under § 103(a) as being unpatentable over Watari (USP No. 5,922,145), Shibata (USP No. 4,773,947) or Eguchi (USP No. 5,746,842) in view of the Annealing of Steel Textbook ("Annealing Textbook"). Independent claims 1, 4, 5 and 7 were rejected under § 103(a) as being unpatentable over Eguchi in view of the Annealing Textbook. Dependent claims were rejected under § 103(a) over Eguchi and Annealing Textbook alone or further in view of additional references. These rejections are respectfully traversed.

The claimed invention is directed to a steel for a high bearing pressure-resistant member, having a high machinability, and a method of making thereof. The steel is formed of a machine structural steel. Claims 1, 4, 5 and 7 recite a steel and a method of producing a steel having the following composition and heat treatment features:

> (1) The machine structural steel contains carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight and not more than 1.23% by weight, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, (a total amount of chromium and molybdenum being within a range between 2.71 and 3.46 % by weight).
>
> (2) The machine structural steel is subjected to a heat treatment for spheroidizing in order to precipitate carbide in the machine structural steel. The heat treatment includes maintaining the machine structural steel at a temperature ranging from 700 to 820 °C;

and cooling the machine structural steel to a temperature of 600 °C at a cooling rate of not higher than 20 °C per one hour.

Claim 20 recites the second feature and a similar first feature, where the silicon, chromium and molybdenum concentration is recited in functional terms. By virtue of the combination of the above two features (1) and (2), i.e., by applying the heat treatment of the conditions of (2) onto the machine structural steel having the composition of (1), the carbide (which is higher in hardness) having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm is formed in the machine structural steel.

Thus, the present inventors unexpectedly discovered that by applying the claimed annealing steps to a steel having the claimed composition, the particle size of the precipitated carbide is made smaller than in prior art machine structural steel. The smaller carbide particle size is advantageous because it reduces the hardness of the steel. With this machine structural steel, shearing force during machining or cutting can be softened while suppressing impact of hard substance or the carbide on the cutting blade of a tool. Accordingly, the claimed machine structural steel is excellent in machinability.

Applicants note that such machine structural steel cannot be obtained even if the claimed heat treatment conditions are applied onto a machine structural steel having a composition other than the claimed composition. For example, as illustrated in Table 2 on page 10 of the present specification, when the claimed spheroidizing heat treatment is applied to low Cr and Mo steel (comparative examples 4 and 5), the average carbide particle is greater than 1 micron. In contrast, when a high temperature (850 C) normalizing heat treatment is applied to the steel composition within the claimed composition range (comparative examples 6, 7 and 8), a steel having a high hardness and inferior machinability results.

Thus, the claimed steel and method provides an unexpected result not apparent from the prior art references, because by using the claimed spheroidizing heat treatment on the steel having the claimed composition, provides a steel with an unexpectedly small carbide particles and low hardness, which provides excellent machinability characteristics.

Page 11 of the Office Action states that "the fact that applicant recognized another advantage which would flow naturally from following the suggestion of the prior art cannot be the basis for patentability when the differences would otherwise be obvious." Applicants respectfully disagree.

A. The Prior Art References Do Not Suggest The Claimed Invention

First, the smaller carbide particle size discovered by the applicants is an unexpected result which does not flow naturally from the suggestion of the prior art. Neither Eguchi nor the Annealing Textbook teach how to obtain the smaller carbide particle size. As discussed in the previous Response, Eguchi teaches to keep the Cr and Mo content below 2.71 %. Furthermore, the Annealing Textbook states that low carbon steels are seldom spheroidized for machining. While this is not an absolute teaching that spheroidizing is not performed on such steels, as noted on page 11 of the Office Action, this Textbook's teaching falls short of providing motivation to one of ordinary skill in the art to conduct a spheroidizing heat treatment on the steel of Eguchi to obtain a low carbon steel for machining, especially at the claimed heat treatment parameters.

Furthermore, even if one of ordinary skill in the art was motivated to conduct a spheroidizing heat treatment on a low carbon steel for machining, and if one of ordinary skill in the art followed the suggestion of Eguchi and the Annealing Textbook, then one of ordinary skill in the art would not achieve the

steel with a small carbide particle size, because conducting a general spheroidizing anneal on a low Cr and Mo content steel would not result in small carbide particles. Neither Eguchi nor the Annealing Textbook teach or suggest that the carbide particle size can be reduced by increasing the Cr and Mo concentration and by conducting the spheroidizing anneal having the claimed parameters. Thus, the advantage does not naturally flow from the teaching of the prior art.

B. The Rejection Is Based On Improper "Obvious To Try" Rationale

Second, the applied prior art references teach many different steel compositions and many different heat treatment schedules which would not lead to the claimed small carbide size. Thus, the § 103(a) rejections are based on an improper "obvious to try" rationale, because the applied prior art does not provide any direction about which parameters are critical to achieving the small carbide size and provides no direction as to which of the many possible choices of parameters would lead to the small carbide size. See MPEP § 2145(X)(B).

C. Unexpected Results

Third, even if there was motivation to combine Eguchi, Watari or Shibata with the Annealing Textbook to establish a prima facie case of obviousness (which the applicants contest), then evidence of unexpected results achieved by the claimed invention is sufficient to rebut the prima facie case of obviousness. As noted above and as described in Table 2 on page 10 of the present specification, when the claimed spheroidizing heat treatment is applied to low Cr and Mo steel (comparative examples 4 and 5), the average carbide particle size is greater than 1 micron. In contrast, when a high temperature (850 C) normalizing heat treatment is applied to the steel composition within the claimed composition range (comparative examples 6, 7 and 8), a steel having a high

hardness results, which has inferior machinability. Thus, only when the claimed spheroidizing heat treatment is applied to a steel having the claimed composition (examples 1-3), then a steel with a low hardness and a low average carbide particle size results. As illustrated in table 3 on page 13 of the present specification, only steels with a low hardness and low average carbide particle size have excellent machinability characteristics. Steels having a composition different from the claimed composition (comparative examples 4, 5, 9 and 10) and steels subjected to a high temperature normalizing heat treatment (comparative examples 6-10) have inferior machinability, and caused breakage of the cutting tool used to machine these steels.

Thus, the claimed steels and methods of making the steel have an unexpected result compared to those of the prior art. Therefore, even if a prima facie case of obviousness is established, these unexpected results are a secondary consideration sufficient to rebut the prima facie case of obviousness.

D. <u>The Claimed Composition Is Not Suggested By Eguchi</u>

Page 11 of the Office Actions states that Eguchi discloses upper end points of 2.5 wt% and 0.7 wt% for Cr and Mo concentrations, respectively, and that these end points are considered to be an actual disclosure of a composition which falls into the claimed range. Applicants submit that these upper ranges of Eguchi could be used in an anticipation rejection under 35 U.S.C. § 102. However, in an obviousness rejection under §103(a), the teaching of the entire reference must be considered. Thus, when the entire teaching of Eguchi is considered, Eguchi teaches away from the claimed combined Cr and Mo concentration of at least 2.71 wt % for reasons discussed in the prior response. Likewise, Watari and Shibata fail to teach or suggest a combined Cr and Mo concentration of at least 2.71 wt.%.

III. Conclusion

Applicants believe that the present application is now in condition for allowance. Favorable reconsideration of the application as amended is respectfully requested. The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

Respectfully submitted,

Date 3/7/03

By [signature]

FOLEY & LARDNER
Washington Harbour
3000 K Street, N.W., Suite 500
Washington, D.C. 20007-5143
Telephone: (202) 672-5300
Facsimile: (202) 672-5399

Leon Radomsky
Attorney for Applicant
Registration No. 43,445

MARKED UP VERSION SHOWING CHANGES MADE

Below are the marked up amended claim(s):

1. (Twice Amended) A steel for a high bearing pressure-resistant member, having a high machinability, said steel being formed of a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight and not more than 1.23 % by weight, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, a total amount of chromium and molybdenum amounting to at least 2.71% by weight, said machine structural steel containing carbide precipitated under a heat treatment for spheroidizing, the carbide having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm, wherein said heat treatment includes maintaining said machine structural steel at a temperature ranging from 700 to 820 °C, and cooling said machine structural steel to a temperature of 600°C at a cooling rate of not higher than 20 °C per one hour.

4. (Twice Amended) A high bearing pressure-resistant member made of a steel which has a high machinability and is formed of a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight and not more than 1.23 % by weight, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, a total amount of chromium and molybdenum amounting to at least 2.71% by weight, said machine structural steel containing carbide precipitated under a heat treatment for spheroidizing, the carbide having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm,

wherein said machine structural steel undergoes one of a first treatment and a second treatment after the spheroidizing heat treatment, said first treatment including hardening the machine structural steel by carburizing, and tempering the hardened machine structural steel, said second treatment including hardening the machine structural steel by carbonitriding, and tempering the hardened machine structural steel, wherein said heat treatment for spheroidizing includes maintaining said machine structural steel at a temperature ranging from 700 to 820 °C, and cooling said machine structural steel to a temperature of 600 °C at a cooling rate of not higher than 20 °C per one hour.

5. (Twice Amended) A method of producing a steel for a high bearing pressure-resistant member, having a high machinability, said method comprising:

preparing a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight and not more than 1.23 % by weight, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, a total amount of chromium and molybdenum amounting to at least 2.71% by weight; and

applying a heat treatment for spheroidizing on said machine structural steel so that carbide is precipitated in said machine structural steel, the carbide having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm, said heat treatment including maintaining said machine structural steel at a temperature ranging from 700 to 820 °C, and cooling said machine structural steel to a temperature of 600 °C at a cooling rate of not higher than 20 °C per one hour.

7. (Twice Amended) A method of producing a high bearing pressure-resistant member, having a high machinability, said method comprising:

preparing a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in an amount of not less than 0.4 % by weight and not more than 1.23 % by weight, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, a total amount of chromium and molybdenum amounting to at least 2.71% by weight;

applying a heat treatment for spheroidizing on said machine structural steel so that carbide is precipitated in said machine structural steel, the carbide having an average particle size of not larger than 1 μm and the maximum particle size of not larger than 3 μm[;], said heat treatment including maintaining said machine structural steel at a temperature ranging from 700 to 820 °C; and cooling said machine structural steel to a temperature of 600 °C at a cooling rate of not higher than 20 °C per one hour;

machining said machine structural steel to have predetermined shape and dimensions; and

applying one of a first treatment and a second treatment on said machine structural steel after the machining, said first treatment including hardening said machine structural steel by carburizing, and tempering said hardened machine structural steel, said second treatment including hardening said machine structural steel by carbonitriding, and tempering said hardened machine structural steel.

20. (Amended) A steel for a high bearing pressure-resistant member, having a high machinability, said steel being formed of a machine structural steel comprising carbon in an amount ranging from 0.15 to 0.25% by weight, silicon in a relatively small amount of not less than 0.4 % by weight, nickel in an amount ranging from 1 to 3 % by weight, chromium in an amount ranging from 1.2 to 3.2 % by weight, and molybdenum in an amount ranging from 0.25 to 2.0 % by weight, said machine structural steel containing carbide precipitated

under a heat treatment for spheroidizing, wherein the total amount of chromium and molybdenum and the conditions of spheroidizing heat treatment are selected such that the carbide has an average particle size of not larger than 1 μm and a maximum particle size of not larger than 3 μm, wherein said heat treatment includes maintaining said machine structural steel at a temperature ranging from 700 to 820 °C, and cooling said machine structural steel to a temperature of 600 °C at a cooling rate of not higher than 20 °C per one hour.